CsI-Silicon Particle detector for Heavy ions Orbiting in Storage rings (CsISiPHOS)*

M.A. Najafi† [2,3], *I. Dillmann*[1,3,5], *F. Bosch*[1], *T. Faestermann*[2], *B. Gao*[1,6], *R. Gernhäuser*[2], *C. Kozhuharov*[1], *S. A. Litvinov*[1], *Yu. A. Litvinov*[1], *L. Maier*[2], *F. Nolden*[1], *U. Popp*[1], *M. S. Sanjari*[1], *U. Spillmann*[1], *M. Steck*[1], *T. Stöhlker*[1], *and H. Weick*[1]

[1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany; [2]Technische Universität München, München, Germany; [3]Justus-Liebig Universtät Giessen, Giessen, Germany; [4]Goethe Universität Frankfurt, Frankfurt, Germany ; [5]TRIUMF, Vancouver, Canada; [6]Max Planck Institute für Kernphysik, Heidelberg, Germany

The β decay of highly-charged ions at the Experimental Storage Ring (ESR) at GSI Darmstadt has been a rich source of new discoveries about decay properties of atomic nuclei [1,2]. A heavy-ion detector was designed and developed for such decay studies, which is also a prototype of the in-pocket detectors for the future ILIMA programme at the Collector Ring (CR) [3] at FAIR. The detector includes a stack of six silicon pad detectors ($60\times40\times0.5$ mm^3), a double-sided silicon strip detector (DSSD) ($60\times40\times0.3$ mm^3), a tantalum slab as passive absorber ($60\times40\times1$ mm^3), and a CsI scintillation detector ($24\times24\times10$ mm^3). The CsI crystal is coupled to a circular silicon photodiode with a diameter of 35 mm. This configuration serves as a $\Delta E/E$ telescope to be used for detection and identification of each incident ion. The versatile design of the detector allows identification of heavy ions at energies up to 400 MeV per nucleon. Furthermore, the trajectory of the daughter ions and recombined parent ions at the position of the pocket is determined using the DSSD.

In a recent experiment at ESR, the detector was placed in a pocket at an outside position in the northern arc, right behind the dipole. The purpose of this experiment was to measure the β^+ decay rate of H-like ^{142}Pm^{60+} ions into ^{142}Nd^{59+}. To generate the ions of interest, a primary beam of ^{152}Sm was impinged on a beryllium target at the entrance of the Fragment Separator (FRS). The ^{142}Pm^{60+} ions were separated using the FRS and then guided to the ESR. After stochastic and electron cooling, the pocket was inserted to the ring and intercepted the daughter ions. Figure 1 shows the position histogram obtained from the DSSD. In addition to the daughter ions (shown in black), another species is observed that can only be from the mother ions that recombined with an electron in the electron cooler, i.e. ^{142}Pm^{59+} (shown in grey). Figure 2 shows the $\Delta E/E$ histogram, in which ΔE was obtained from the sum of the energy signals of each silicon pad detector and E from the energy signals of the CsI scintillator. With an energy-deposit resolution (FWHM) of 60 MeV at 6.7 GeV, and a total energy resolution of 330 MeV at 56.8 GeV, the detector can identify neighbouring isobars distinctly.

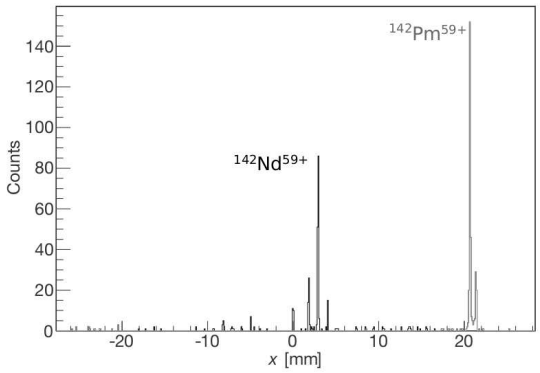

Figure 1: Position of the ions on the DSSD. The grey histogram represents the recombined mother ions, ^{142}Pm^{59+}.

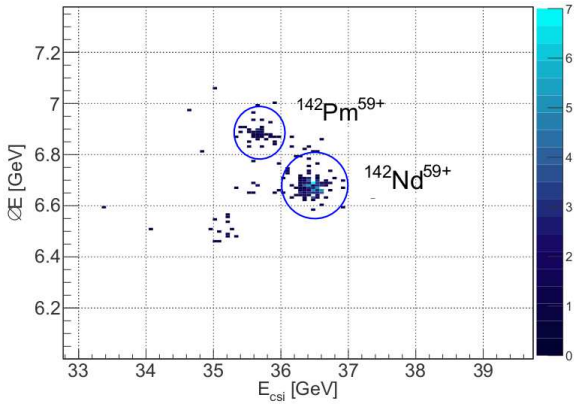

Figure 2: Total energy deposit in silicon pad detectors, ΔE, versus energy in CsI, E_{CsI}.

References

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* Work supported by the BMBF project 05P12RGFNJ (Multi-purpose pocket detector for in-ring decay spectroscopy), and the Helmholtz association via the Young Investigators Project "LISA: Lifetime Spectroscopy for Astrophysics" (VH NG 627), and the Maier-Leibnitz Laboratory in Munich. Authors are grateful for the essential help of M. Böhmer (TUM), GSI target lab, and GSI accelerator staff.

† m.a.najafi@gsi.de

DOI:10.15120/GR-2015-1-APPA-MML-AP-29